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WIP: A Biomedical Engineering Design Teaching Circle to Support Design Instruction Through an Undergraduate Curriculum

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Background

Many undergraduate biomedical engineering (BME) programs integrate a team-based, capstone design project as a culminating experience that aims to prepare students to be confident, industry-ready engineers while also meeting the learning objectives outlined by program accreditors [1], [2]. Despite work showing that integrating team-based design experiences throughout a curriculum can improve student design self-efficacy [3], delivering design content and skills that permeate all levels of the BME curriculum can be particularly challenging in large engineering programs with multiple design instructors [4]. Thus, cohesive instructional teams are needed to seamlessly deliver meaningful design experiences to undergraduate biomedical engineering students.

With similar objectives of building community, creating shared understanding of content, and fostering discussion, both formal and informal faculty professional development opportunities may facilitate cohesive instructional delivery of design concepts and skills [5], [6]. Faculty learning communities can offer a formal way to engage instructors but often require longer time commitments, written reports, or formal assessments; however, teaching circles have similar objectives with a more informal structure [6]. This work in progress shares how we assembled a BME Design Teaching Circle to identify and to discuss best practices in delivering design content throughout the undergraduate curriculum being delivered at multiple locations. In addition, we summarize the topics, opportunities and actions guiding our continuous improvement process.

Teaching Circle Participants and Structure

Our BME Design Teaching Circle includes ten participants (West Lafayette and Indianapolis evenly represented) comprised of four faculty, four staff and two graduate student teaching assistants. BME Design instructors across both locations and two recommended graduate students were invited to participate. From exemplars to explorers, participants represent the five elements of teaching excellence at Purdue University [7], and collectively we implement equal participation, equal commitment, consistent attendance, open mindedness, and attentiveness to participation as key tenets. Our initial efforts to date have provided an opportunity for BME design instructors to engage with like-minded colleagues [4] in a low-stakes environment to discuss BME design topics.

The BME Design Teaching Circle is co-led by two facilitators, one at each location, and meets monthly (four times per semester) for 75-minute sessions to discuss BME design topics. Our ABET coordinator is a lead participant and brings perspective on how this team can contribute toward our continuous improvement plan. Each meeting provides five minutes of overview content followed by one BME design question. Discussion topics were solicited from participants, and the facilitator team finalized the questions. Most meetings are scheduled as virtual meetings; however, one meeting each semester is scheduled in person to promote team building across locations. A MS Teams channel is used to organize discussion questions, notes, announcements, and resources. Departmental resources included course sequencing via the plan of study, learning outcomes mapped to each BME course within that plan, and syllabi for undergraduate design courses.

The first sessions provided opportunity to discuss four prompts: *What engineering design content do/should BME students learn?*; *What should BME students learn in junior year in preparation for capstone?*; *What best practices occur in our current BME senior design instruction?;* and *How are senior design projects recruited?*. The session that discussed best practices collected real-time participant feedback using a Miro Board.

Discussion Summaries

By leading these discussions with student centered teaching practices in mind [5], we have identified several recommended actions and areas to review for improvement.

Prompt 1: What engineering design content do/should BME students learn?

In our first discussion, three main content areas surfaced as content BME students should learn: (1) design vocabulary (including design controls), (2) engineering standards, and (3) experimental design. While design vocabulary was introduced in most lab and design activities, it was evident that different courses were using different terms without understanding how design vocabulary is emphasized in pre-requisite or subsequent courses. When discussing engineering standards, the group learned that this content is introduced early but can be reinforced in latter coursework. Our discussion also captured the need to include biomedical engineering design instruction that considers and involves standard testing (e.g., ASTM), guidelines (e.g., CDC), and medical insurance program codes (e.g., categories I and II CPT codes). Verification testing through appropriate experimental design was offered as another curricular area to review for improvement. The team identified the following action items:

- Create a unified design vocabulary resource to be used throughout the BME undergraduate curriculum. Because teaching assignments can change each year, it is recommended that this resource be provided yearly to BME instructors that teach design.
- While engineering standards are present in 200-/300-level lab courses, a summary flyer with engineering standards, safety requirement resources, and medical insurance program codes via links and/or QR codes would be helpful to post in our BME design spaces.
- Review how experimental design and citations are introduced and reinforced. Suggestions included a one-page citation expectation resource for instructors and an entry-level journal club during 200-level instruction.

Prompt 2: What should BME students learn in junior year in preparation for capstone?

After reviewing the undergraduate BME course sequencing and learning outcomes, our second discussion identified areas in the junior year for further review, detailed what design concepts are needed before capstone, and surfaced instructor communication recommendations. The group identified a specific list of design concepts that could be introduced earlier than capstone and noted that areas within the curriculum that are particularly demanding of students.

- Introduce the following design concepts prior to capstone: device classification, ideation, gap analysis, research, cycle of care, observation. For example, a chatbot could be developed to practice mock observation and/or interview training prior to capstone.
- Develop a best practice (e.g., summary sheet of course descriptions or projects) to share more broadly what design projects students work on throughout the curriculum.

Prompt 3: What best practices occur in our current BME senior design instruction?

The facilitators identified 9 primary themes to ground this discussion, including design process, mentor communication, evaluation and feedback, logistics, team management, division of tasks, in-class activities, presentations, and engineering identity. Using an online collaboration board (Miro), participants added best practices from their respective experiences to each category. This led to more extensive discussions on select best practices amongst the group, with some areas of strength and growth emerging. On the topic of team management, an extensive discussion on team contracts, how we integrate them into team deliverables, and areas for improvement led to agreement on more active integration and revisiting throughout the course.

Prompt 4: How are senior design projects recruited?
This topic was chosen strategically for the end of the semester to drive a discussion on our recruitment strategies and acceptance criteria for projects based on recent and past experiences. This also helped lay the groundwork for continuous improvement actions to be taken in preparing for the next project recruitment cycle. Amongst the many logistical and technical aspects of project recruitment, discussions covered project scoping, mentor and sponsor engagement, industry sponsorship, and maintaining networks. Suggested areas to review and improve included:

- Identify how and what industry and clinical partnerships are already present or in process at the program level and how to best coordinate senior design recruitment within these efforts. Emphasis would be on standardizing and collaborating project recruitment across both locations and on supporting both one- and two-semester capstone design options.
- Connecting with key leaders within the department to build clinical and industry collaborations in different specializations (e.g., pediatrics, cardiovascular, orthopedics).

The low-stakes environment of this collaboration encouraged participation from faculty, staff, and graduate student teaching assistants (TAs). The intentional inclusion of TAs provided additional insight, as one graduate student who previously experienced the undergraduate BME curriculum recalled the time-consuming need to level-set with capstone teammates on both design and teaming items. While learning how to project manage with a team is often a goal of engineering capstone experiences, improved guidance may lessen the difficulty of navigating and implementing new design and teaming skills in the final year of BME senior design. Introducing design content (e.g., terminology, standards, citation methods) earlier in the curriculum at an appropriate level and doing so consistently became an apparent area of improvement from a TA perspective.

Conclusion and Future Directions

Our need to deliver excellent design experiences to large classes spanning two physical locations has instigated a BME Design Teaching Circle that discusses how to deliver high-quality experiences in a demanding curriculum. Our sessions surfaced five recommended action items that may inform pedagogical changes to design instruction and three suggestions that could increase departmental awareness of the BME capstone process and experience. Our ideas will be shared with the BME Undergraduate Curriculum Committee, the committee with leadership that informs curricular initiatives. Future BME Design Teaching Circle sessions will be convened to discuss intellectual property, showcasing student work, and supporting design competition participation.

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References

[1] "Criteria for Accrediting Engineering Programs, 2025 - 2026," ABET. Accessed: Oct. 13, 2025. [Online]. Available: https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2025-2026/

[2] P. H. King and R. Fries, "Designing Biomedical Engineering Design Courses," *Int. J. Eng. Educ.*, vol. 19, no. 2, pp. 346–353, 2003.

[3] S. Higbee, D. Harrell, A. Chase, and S. Miller, "A Study of Biomedical Engineering Student Self-efficacy toward Design throughout an Undergraduate BME Curriculum," *Biomed. Eng. Educ.*, Jan. 2025, doi: 10.1007/s43683-024-00163-5.

[4] C. J. Finelli and J. M. Millunchick, "The Teaching Circle for Large Engineering Courses: Clearing the Activation Barrier," presented at the 2013 ASEE Annual Conference & Exposition, June 2013, p. 23.1239.1-23.1239.9. Accessed: Oct. 13, 2025. [Online]. Available: https://peer.asee.org/the-teaching-circle-for-large-engineering-courses-clearing-the-activation-barrier

[5] M. V. Jamieson and J. M. Shaw, "Teaching engineering innovation, design, and leadership through a community of practice," *Educ. Chem. Eng.*, vol. 31, pp. 54–61, Apr. 2020, doi: 10.1016/j.ece.2020.04.001.

[6] M. J. Marshall, "Teaching Circles: Supporting Shared Work and Professional Development," *Pedagogy*, vol. 8, no. 3, pp. 413–431, Oct. 2008, doi: 10.1215/15314200-2008-003.

[7] "The Framework for Teaching Excellence." Accessed: Dec. 30, 2025. [Online]. Available: https://www.purdue.edu/provost/teaching-excellence/defining/